

1 VI. CLAIMS

2
3 WHAT IS CLAIMED IS:

- 4
- 5 1. A method of simulating and optimizing qualification testing of
6 lubricating oil products, the method comprising:
- 7 a. passing a plurality of lubricating oil product characteristics to a
8 simulator engine, wherein the simulator engine comprises a
9 plurality of simulated qualification tests and processing the
10 lubricating oil product characteristics in one or more of the
11 simulated qualification tests, wherein the output of each
12 simulated qualification test includes a probability of passing
13 indicator for indicating the probability that a lubricating oil
14 product have the inputted characteristics would pass an actual
15 qualification test;
- 16 b. passing an input of the plurality of lubricating oil product
17 characteristics, the probability of passing indicator from each
18 simulated qualification test, and a proposed test sequence of a
19 plurality of qualification tests to a strategy simulator engine and
20 processing the input to determine a probability of passing
21 indicator, cost and time duration of the proposed test sequence.
- 22
- 23 2. The method of claim 1, further comprising passing as a second input
24 the plurality of lubricating oil product characteristics, the proposed test
25 sequence and the probability of passing indicator from each simulated
26 qualification test to an strategy optimizer engine and processing the
27 second input to determine an optimum test sequence, based on pre-
28 determined criteria, for performing actual qualification tests.

- 1 3. The method of claim 2, wherein the strategy optimizer engine utilizes
2 optimizing techniques selected from genetic algorithms, simulated
3 annealing, and mixtures thereof.
4
- 5 4. The method of claim 2, wherein the pre-determined criteria comprise
6 test sequence cost and test sequence time duration.
7
- 8 5. The method of claim 2, wherein the simulator engine is configured to
9 account for a random factor for each simulated qualification test.
10
- 11 6. The method of claim 1, wherein the simulated qualification tests are
12 modeled using as a third input data from actual qualification tests with
13 modeling techniques selected from neural networks, Bayesian network,
14 and mixtures thereof.
15
- 16 7. The method of claim 6, wherein the third input further comprises data
17 from expert knowledge and wherein the modeling technique is the
18 Bayesian network modeling technique.
19
- 20 8. The method of claim 1, wherein the lubricating oil product
21 characteristics comprise base oil percentage and characteristics,
22 viscosity index improver percentage and characteristics, additives
23 percentage and characteristics, and pour point depressants percentage
24 and characteristics.
25
- 26 9. The method of claim 1, wherein the strategy simulator engine utilizes
27 Monte Carlo statistical techniques.
28
- 29 10. The method of claim 9, wherein the strategy simulator engine is
30 configured to operate in series or in parallel on the individual simulated
31 qualification tests of the test sequence.

- 1 11. The method of claim 1, wherein the strategy simulator engine is
2 configured to change the characteristics of the lubricating oil product
3 under test in a manner consistent with a pre-determined Codes of
4 Practice for lubricant oil testing where the initial characteristics would
5 not result in the lubricating oil product passing all qualification tests.
6
- 7 12. The method of claim 10, wherein the pre-determined Codes of Practice
8 comprise permissible mid-test sequence changes of the characteristics
9 of the lubricating oil product under test and permissible multi-grade
10 tests.
11
- 12 13. The method of claim 9, wherein the strategy simulator engine is
13 configured to produce an output for a plurality of variations of
14 lubricating oil product characteristics.
15
- 16 14. The method of claim 8, wherein Codes of Practice are entered into the
17 strategy simulator engine via a Rules Engine.
18
- 19 15. The method of claim 9, wherein the Rules Engine is configured and
20 adapted to accept Rules of Practice input via a plain-English interface,
21 and wherein the Rules Engine processes the input into a computer
22 programming language format which provides instructions which the
23 strategy simulator engine can read and follow.
24
- 25 16. A system for simulating and optimizing qualification testing of
26 lubricating oil products, the system comprising:
27 a. a CPU;
28 b. a memory operatively connected to the CPU, the memory
29 containing a program adapted to be executed by the CPU and
30 the CPU and memory cooperatively adapted for simulating
31 qualification testing of lubricating oil products;

- 1 c. a simulator engine code segment embodied on a computer-
2 readable medium configured and adapted for receiving as input
3 a plurality of lubricating oil product characteristics, wherein the
4 simulator engine comprises a plurality of simulated qualification
5 test code segments, and configured and adapted for processing
6 the input of lubricating oil product characteristics in one or more
7 of the simulated qualification test code segments, wherein the
8 output of each simulated qualification test code segments
9 includes a probability of passing indicator for indicating the
10 probability that a lubricating oil product have the inputted
11 characteristics would pass an actual qualification test;
- 12 d. a strategy simulator code segment embodied on a computer-
13 readable medium configured and adapted for receiving as a
14 second input the plurality of lubricating oil product
15 characteristics, the probability of passing indicator from each
16 simulated qualification test code segment, the plurality of
17 lubricating oil product characteristics, and a proposed test
18 sequence of a plurality of qualification tests, and processing the
19 second input to determine a probability of passing indicator, cost
20 and time duration of the proposed test sequence.
- 21
- 22 17. The system of claim 16, further comprising a strategy optimizer engine
23 code segment embodied on a computer-readable medium configured
24 and adapted for receiving as a third input an initial test sequence, the
25 plurality of lubricating oil product characteristics, and the probability of
26 passing indicator from each simulated qualification test, and processing
27 the third input to determine an optimum test sequence, based on pre-
28 determined criteria, for performing actual qualification tests.

- 1 18. The system of claim 17, wherein the strategy optimizer engine code
2 segment utilizes optimizing techniques selected from genetic
3 algorithms, simulated annealing, and mixtures thereof.
4
- 5 19. The system of claim 17, wherein the pre-determined criteria comprise
6 test sequence cost and test sequence time duration.
7
- 8 20. The system of claim 17, wherein the strategy optimizer engine code
9 segment is configured and adapted to account for a random factor for
10 each simulated qualification test.
11
- 12 21. The system of claim 16, wherein the simulated qualification test code
13 segments are constructed from a fourth input of data from a database
14 of actual qualification tests with modeling techniques selected from
15 neural networks, Bayesian network, and mixtures thereof.
16
- 17 22. The system of claim 21, wherein the fourth input further comprises data
18 from a database of expert knowledge and wherein the modeling
19 technique is the Bayesian network modeling technique.
20
- 21 23. The system of claim 16, wherein the input of lubricating oil product
22 characteristics comprises base oil percentage and characteristics,
23 viscosity index improver percentage and characteristics, additives
24 percentage and characteristics, and pour point depressants percentage
25 and characteristics.
26
- 27 24. The system of claim 16, wherein the strategy simulator engine code
28 segment is constructed from Monte Carlo statistical techniques.

- 1 25. The system of claim 24, wherein the strategy simulator engine code
2 segment is configured and adapted to process in series or in parallel
3 the input of individual simulated qualification tests of the test sequence.
4
- 5 26. The system of claim 16, wherein the strategy simulator engine code
6 segment is configured and adapted to change the characteristics of the
7 lubricating oil product under test in a manner consistent with a pre-
8 determined Codes of Practice for lubricant oil testing where the initial
9 characteristics would not result in the lubricating oil product passing all
10 qualification tests.
11
- 12 27. The system of claim 26, wherein the pre-determined Codes of Practice
13 comprise permissible mid-test sequence changes of the characteristics
14 of the lubricating oil product under test and permissible multi-grade
15 tests.
16
- 17 28. The system of claim 26, wherein the strategy simulator engine code
18 segment is configured and adapted to produce an output of a plurality
19 of variations of lubricating oil product characteristics.
20
- 21 29. The system of claim 26, further comprising a Rules Engine code
22 segment for incorporating the Codes of Practice into the strategy
23 simulator engine.
24
- 25 30. The system of claim 26, wherein the Rules Engine code segment is
26 configured and adapted to accept Codes of Practice input via a plain-
27 English interface, and wherein the Rules Engine code segment
28 translates the input into a computer programming language code
29 segment configured and adapted provides instructions which the
30 strategy simulator engine segment can read and follow.